19-2299; Rev 0; 1/02

ADSL Drivers/Receivers for Customer Premise Equipment

General Description

The MAX4361/MAX4362/MAX4363 are a family of high-performance ADSL drivers and drivers/receivers ideal for the upstream transmit path and the downstream receive path of customer premise equipment. These devices operate from a single 5V supply and deliver up to 12.5dBm average line power for DMT modulated signals, meeting the requirements of full-rate ADSL. Spurious-free dynamic range (SFDR) at full output power is typically -75dBC at 100kHz.

The MAX4361 is a differential IN/differential OUT driver with a fixed gain of 3.1V/V. The MAX4362 is a dual amplifier with shutdown intended for use as a differential IN/differential OUT driver with gain set with external resistors. The MAX4363 is a quad amplifier with shutdown intended for use as a differential IN/differential OUT driver/receiver combination with gain set with external resistors.

The MAX4361 is offered in a space-saving 8-pin µMAX package.

Applications

ADSL Line Interface

HDSL Line Driver

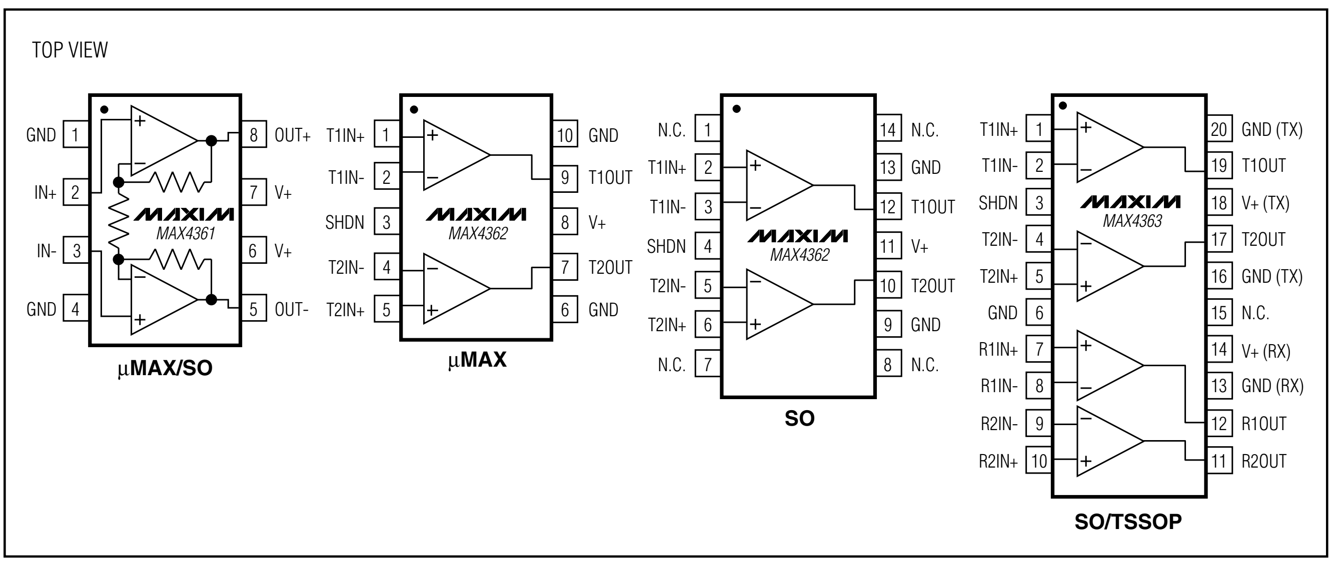
Features

- **Low-Noise Driver**
  - **4.8nV/$\sqrt{Hz}$ Voltage-Noise Density**
  - **1.5pA/$\sqrt{Hz}$ Current-Noise Density**
- **Full-Rate ADSL ATU-R Line Drivers and Receivers**
- **Single 5V Supply**
- **-75dBc SFDR at Full Output Power at 100kHz**
- **-95dB Driver-to-Receiver Crosstalk (MAX4363)**
- **+12.5dBm Average Line Power (DMT)**
- **280mA (min) Peak Output Current**
- **Rail-to-Rail® Output Swing**
- **Thermal and Short-Circuit Protection**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4361EUA	-40°C to +85°C	8 µMAX
MAX4361ESA	-40°C to +85°C	8 SO
MAX4362EUB	-40°C to +85°C	10 µMAX
MAX4362ESD	-40°C to +85°C	14 SO
MAX4363EUP	-40°C to +85°C	20 TSSOP
MAX4363ESP	-40°C to +85°C	20 SO

Pin Configurations



Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

ADSL Drivers/Receivers for Customer Premise Equipment

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V+ to GND) ....-0.3V to +6V
Analog Input Voltage ....(GND - 0.3V) to (V+ + 0.3V)
SHDN Input Voltage.........................(GND - 0.3V) to (V+ + 0.3V)
Output Short-Circuit Duration 10s
Driver Output Current...1A
Receiver Output Current 150mA
Continuous Power Dissipation (T_A = +70°C)
8-Pin µMAX (derate 4.5mW/°C above +70°C) 362mW
10-Pin µMAX (derate 5.6mW/°C above +70°C) 444mW
8-Pin SO (derate 5.88mW/°C above +70°C).................471mW
14-Pin SO (derate 8.33mW/°C above +70°C)...............667mW
20-Pin SO (derate 10.0mW/°C above +70°C)...............800mW
20-Pin TSSOP (derate 10.9mW/°C above +70°C) 879mW
Operating Temperature Range ....-40°C to +85°C
Junction Temperature ....+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Driver

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = 12.5Ω, SHDN = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values specified at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range (Note 1)	V_{CC}			4.5		5.5	V
Supply Current	I_Q	MAX4361, R_L = ∞			22	33	mA
		MAX4362, R_L = ∞	SHDN = 0		22	33	mA
			SHDN = 5V		60	200	µA
		MAX4363, measured at V+ (TX), R_L = ∞	SHDN = 0		22	33	mA
			SHDN = 5V		60	200	µA
		MAX4363, measured at V+ (RX), R_L = ∞	SHDN = 0		4	6.5	mA
			SHDN = 5V		70	200	µA
Maximum Average Output Power (Notes 2, 3)	P_{OUT}	DMT modulation		15.5			dBm
		CAP modulation		18			
Gain	G	MAX4361 (0.7V ≤ V_{OUT} ≤ (V+) - 0.7V)		3.0	3.1	3.2	V/V
Open-Loop Gain	A_{VOL}	MAX4362/MAX4363 (0.7V ≤ V_{OUT} ≤ (V+) - 0.7V)		68	81		dB
Second Harmonic Distortion (Notes 3, 4)		G = 3.1, f = 100kHz, $V_{OUT(DIFF)}$ = 7.1V_{P-P}		-66	-76		dBc
Third Harmonic Distortion (Notes 3, 4)		G = 3.1, f = 100kHz, $V_{OUT(DIFF)}$ = 7.1V_{P-P}		-68	-79		dBc
Peak Output Current	I_{OUT}	Inferred from Output Voltage Swing test		280	330		mA
Input Offset Voltage	V_{OS}				±0.5	±10	mV
Input Bias Current	I_B				1.6	4.5	µA
Input Offset Current	I_{OS}	MAX4361			±30	±600	nA
		MAX4362/MAX4363			±10	±500	
Differential Input Resistance	$R_{IN(DIFF)}$	MAX4361			25		MΩ
		MAX4362/MAX4363			40		kΩ

ELECTRICAL CHARACTERISTICS—Driver (continued)

($V+ = 5V$, GND = 0, $V_{CM} = 2.5V$, $R_L = 12.5\Omega$, SHDN = 0, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values specified at $T_A = +25°C$.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Common-Mode Voltage Range	V_{CM}	Inferred from CMRR test		1.25		4.50	V
Common-Mode Rejection Ratio	CMRR	$1.25V \le V_{CM} \le 4.5V$	MAX4361	60	73		dB
			MAX4362/MAX4363	70	85		
Power-Supply Rejection Ratio	PSRR	V+ = 4.5V to 5.5V	MAX4361	60	89		dB
			MAX4362/MAX4363	60	74		
AC Power-Supply Rejection Ratio	$PSRR_{AC}$	f = 100kHz	MAX4361		63		dB
			MAX4362/MAX4363		49		
Differential Output-Voltage Swing (Note 4)	$V_{OUT(DIFF)}$	Inferred from Output Voltage Swing test		7.4	8.2		V_{P-P}
Output-Voltage Swing (Note 4)	V_{OH}, V_{OL}	$R_L = 100\Omega$	$(V+) - V_{OH}$		215	550	mV
			V_{OL}		230	550	
		MAX4362/MAX4363 $R_L = 12.5\Omega$	$(V+) - V_{OH}$		400	600	
			V_{OL}		430	650	
		MAX4361, $R_L = 12.5\Omega$, $T_A = -20°C$ to $85°C$	$(V+) - V_{OH}$		400	600	
			V_{OL}		430	650	
Output Short-Circuit Current	I_{SC}				±650		mA
Output Resistance	R_{OUT}	MAX4361			0.3		Ω
		MAX4362/MAX4363, G = 1			0.001		
SHDN Logic Low	V_{IL}					0.8	V
SHDN Logic High	V_{IH}			2.0			V
SHDN Input Current	I_{IH}, I_{IL}	SHDN = 0 or SHDN = V+				±10	µA
Shutdown Output Impedance	$Z_{OUT(SD)}$	f = 1MHz			1.8		kΩ
-3dB Bandwidth	BW	MAX4361			40		MHz
		MAX4362/MAX4363, G = 1			60		
Slew Rate	SR	$V_{OUT(DIFF)} = 7.1V_{P-P}$ step			30		V/µs
Settling Time (1%)	t_S	$V_{OUT(DIFF)} = 7.1V_{P-P}$ step	MAX4361		115		ns
			MAX4362/MAX4363, G = 3		165		
Voltage-Noise Density	e_n	f = 100kHz to 1.1MHz			4.8		$nV/\sqrt{Hz}$
Current-Noise Density	i_n	f = 100kHz to 1.1MHz			1.5		$pA/\sqrt{Hz}$
Capacitive-Load Stability					10		nF
Shutdown Delay Time	t_{SHDN}				400		ns
Enable Delay Time	t_{ENABLE}				2.8		µs

ELECTRICAL CHARACTERISTICS—Receiver (MAX4363 only)

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = ∞, SHDN = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values specified at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Spurious-Free Dynamic Range	SFDR	G = 1, f = 1MHz, V_{OUT} = $1V_{P-P}$		-75		dBc
Gain-Bandwidth Product	GBW			190		MHz
Open-Loop Gain	A_{VOL}	1.5V ≤ V_{OUT} ≤ 3.5V	65	77		dB
Peak Output Current	I_{OUT}	R_L = 50Ω, inferred from Output-Voltage Swing test	18	25		mA
Input Offset Voltage	V_{OS}			±0.5	±10	mV
Input Bias Current	I_B			-0.75	-2	µA
Input Offset Current	I_{OS}			±20	±250	nA
Input Capacitance	C_{IN}			1.6		pF
Differential Input Resistance	$R_{IN(DIFF)}$			76		kΩ
Input Common-Mode Voltage Range	V_{CM}	Inferred from CMRR test	0.25		3.80	V
Common-Mode Rejection Ratio	C_{MRR}	0.25V ≤ V_{CM} ≤ 3.8V	70	87		dB
Power-Supply Rejection Ratio	PSRR	V+ = 4.5V to 5.5V	60	75		dB
AC Power-Supply Rejection Ratio	$PSRR_{AC}$	f = 1MHz		47		dB
Output-Voltage Swing	V_{OH}, V_{OL}	R_L = ∞, (V+) - V_{OH}		0.64	1	V
		R_L = ∞, V_{OL}		0.73	1	
		R_L = 50Ω, (V+) - V_{OH}		1.27	1.5	
		R_L = 50Ω, V_{OL}		1.37	1.6	
Output Short-Circuit Current	I_{SC}			±130		mA
Output Resistance	R_{OUT}	G = 1		0.001		Ω
Slew Rate	SR	V_{OUT} = $1V_{P-P}$ step		160		V/µs
Settling Time (1%)	t_S	V_{OUT} = $100mV_{P-P}$ step, G = 1		40		ns
Voltage-Noise Density	e_n	f = 1MHz		8.5		nV/√Hz
Current-Noise Density	i_n	f = 1MHz		0.5		pA/√Hz
Driver-Receiver Crosstalk	X_{TALK}	f = 100kHz		95		dB

Note 1: Guaranteed by the Power-Supply Rejection Ratio (PSRR) test.

Note 2: Implied by worst-case output-voltage swing ($V_{OUT(DIFF)}$), crest factor (C_r) and load resistance (R_L):
P_{Driver} = 10log((250 × ($V_{OUT(DIFF)}$)^2 / ((C_r)^2 × R_L)) dBmW

Note 3: Guaranteed by design.

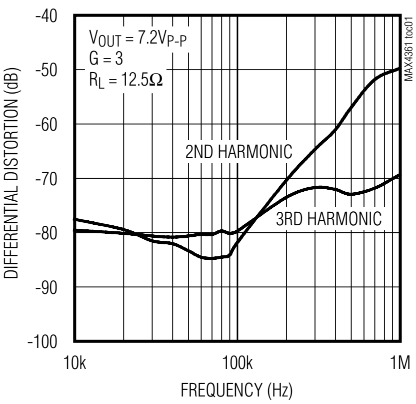
Note 4: May exceed absolute maximum ratings for power dissipation if unit is subject to full-scale sinusoids for long periods (see *Applications Information* section).

ADSL Drivers/Receivers for Customer Premise Equipment

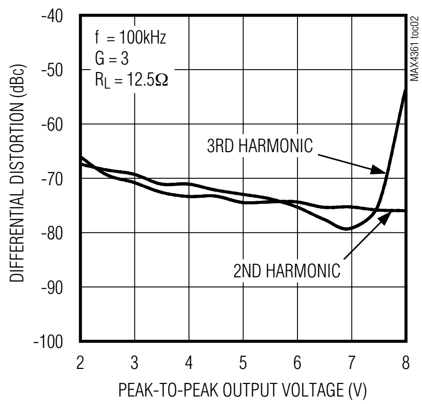
Typical Operating Characteristics

($V+ = 5V$, GND = 0, $V_{CM} = 2.5V$, $R_L = 12.5\Omega$, SHDN = 0, $T_A = +25°C$.)

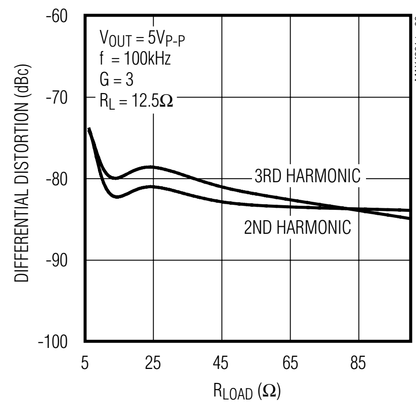
DRIVER DIFFERENTIAL DISTORTION vs. FREQUENCY



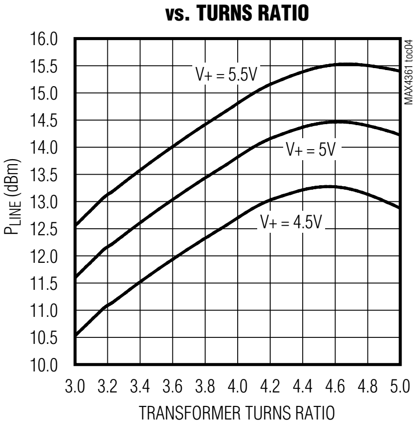
DRIVER DIFFERENTIAL DISTORTION vs. PEAK-TO-PEAK OUTPUT VOLTAGE



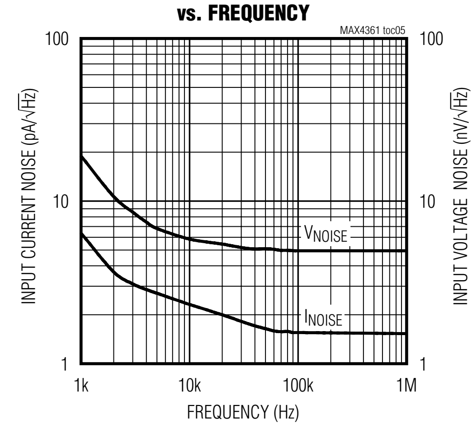
DRIVER DIFFERENTIAL DISTORTION vs. LOAD RESISTANCE



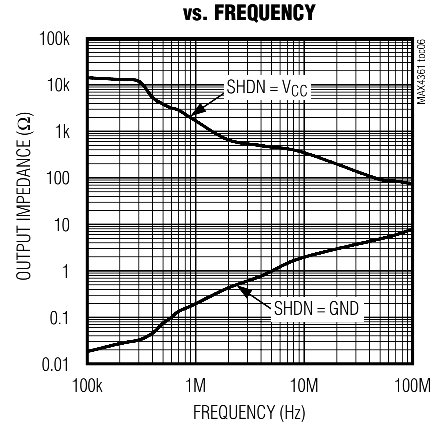
DRIVER LINE POWER vs. TURNS RATIO



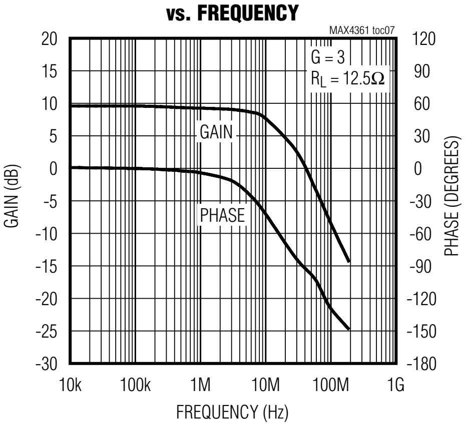
DRIVER CURRENT AND VOLTAGE NOISE vs. FREQUENCY



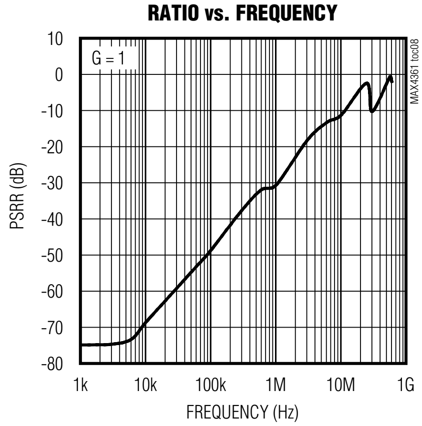
DRIVER OUTPUT IMPEDANCE vs. FREQUENCY



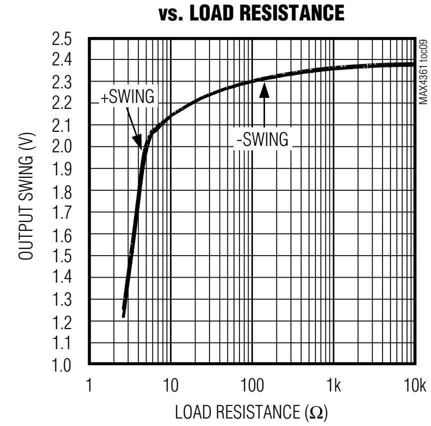
DRIVER GAIN AND PHASE vs. FREQUENCY



DRIVER POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



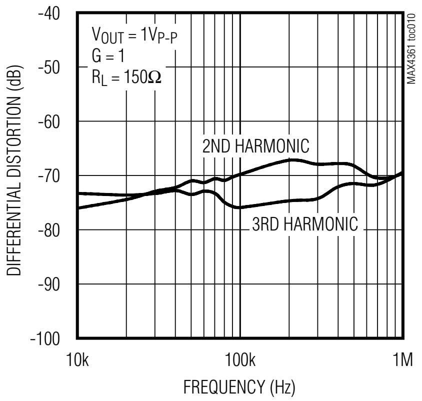
DRIVER OUTPUT SWING vs. LOAD RESISTANCE



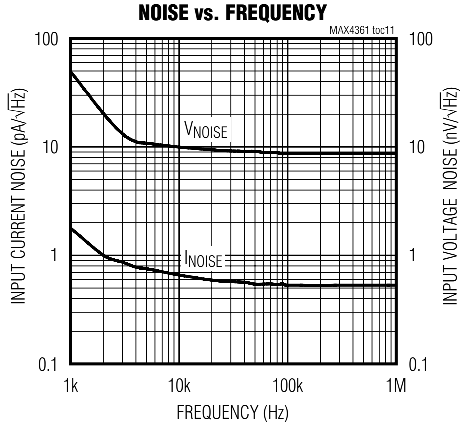
Typical Operating Characteristics (continued)

(V+ = 5V, GND = 0, V_{CM} = 2.5V, R_L = 12.5Ω, SHDN = 0, T_A = +25°C.)

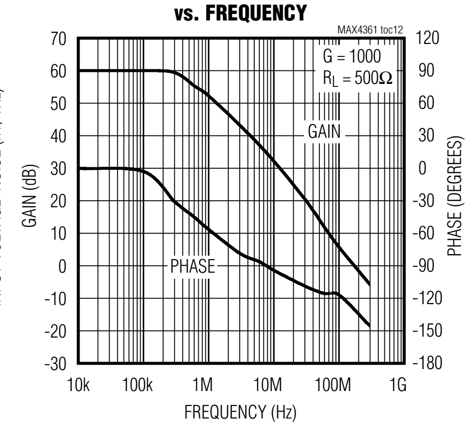
RECEIVER DIFFERENTIAL DISTORTION vs. FREQUENCY



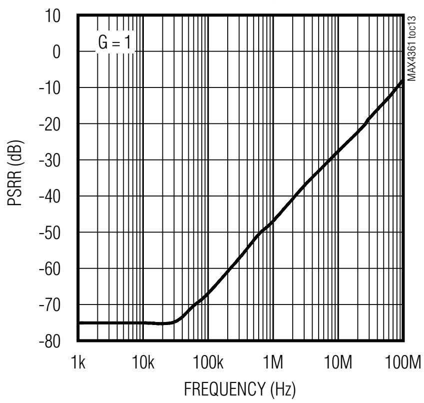
RECEIVER CURRENT AND VOLTAGE NOISE vs. FREQUENCY



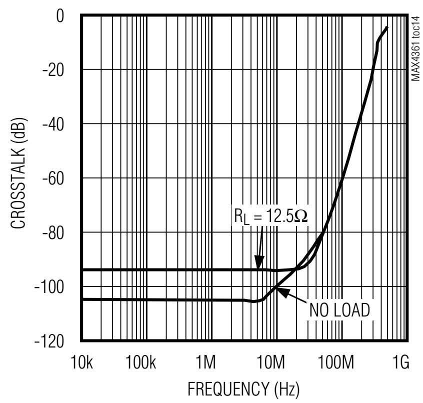
RECEIVER GAIN AND PHASE vs. FREQUENCY



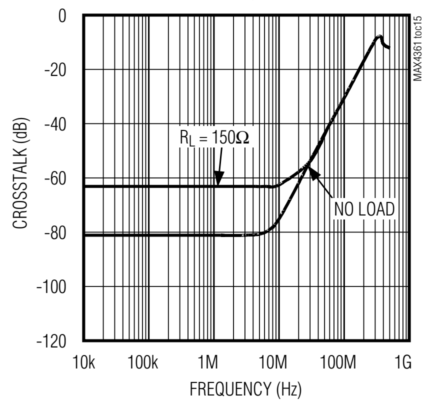
RECEIVER POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



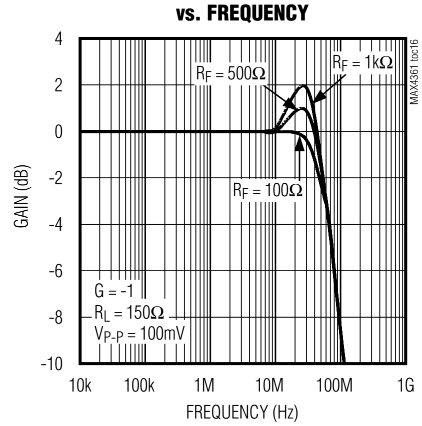
DRIVER-TO-RECEIVER CROSSTALK vs. FREQUENCY



RECEIVER-TO-RECEIVER CROSSTALK vs. FREQUENCY



RECEIVER OUTPUT AMPLITUDE vs. FREQUENCY



Pin Descriptions

MAX4361

PIN	NAME	FUNCTION
1, 4	GND	Ground
2	IN+	First Driver Input
3	IN-	Second Driver Input
5	OUT-	Second Driver Output
6, 7	V+	Positive Power-Supply Voltage. Bypass V+ to GND with a 0.1µF capacitor.
8	OUT+	First Driver Output

MAX4362

PIN		NAME	FUNCTION
µMAX	SO		
1	2	T1IN+	First Driver Noninverting Input
2	3	T1IN-	First Driver Inverting Input
3	4	SHDN	Shutdown. Connect to GND for normal operation.
4	5	T2IN-	Second Driver Inverting Input
5	6	T2IN+	Second Driver Noninverting Input
6, 10	9, 13	GND	Ground
7	10	T2OUT	Second Driver Output
8	11	V+	Positive Power-Supply Voltage. Bypass V+ to GND with a 0.1µF capacitor.
9	12	T1OUT	First Driver Output
—	1, 7, 8, 14	N.C.	No Connection. Not internally connected.

Pin Descriptions (continued)

MAX4363

PIN	NAME	FUNCTION
1	T1IN+	First Driver Noninverting Input
2	T1IN-	First Driver Inverting Input
3	SHDN	Shutdown. Connect to GND for normal operation.
4	T2IN-	Second Driver Inverting Input
5	T2IN+	Second Driver Noninverting Input
6	GND	Ground
7	R1IN+	First Receiver Noninverting Input
8	R1IN-	First Receiver Inverting Input
9	R2IN-	Second Receiver Inverting Input
10	R2IN+	Second Receiver Noninverting Input
11	R2OUT	Second Receiver Output
12	R1OUT	First Receiver Output
13	GND (RX)	Ground for Receiver Amplifiers
14	V+ (RX)	Positive Power-Supply Voltage for Receiver Amplifiers. Bypass V+ (RX) to GND (RX) with a separate 0.1µF capacitor.
15	N.C.	No Connection. Not internally connected.
16, 20	GND (TX)	Ground for Driver Amplifier
17	T2OUT	Second Driver Output
18	V+ (TX)	Positive Power-Supply Voltage for Driver Amplifiers. Bypass V+ (TX) to GND (TX) with a separate 0.1µF capacitor.
19	T1OUT	First Driver Output

Detailed Description

The MAX4361/MAX4362/MAX4363 are a family of high-performance ADSL drivers and drivers/receivers ideal for the upstream transmit path and the downstream receive path of customer premise equipment. These devices operate from a single 5V supply and deliver up to 12.5dBm average line power for DMT modulated signals, meeting the requirements of full-rate ADSL. SFDR at full output power is typically -75dBc at 100kHz.

Differential In/Differential Out ADSL Driver (MAX4361)

The MAX4361 is a differential line driver with a fixed gain of 3.1V/V. The gain is set by three internal resistors.

Uncommitted Dual Amplifier for ADSL Driver (MAX4362)

The MAX4362 is a dual amplifier with shutdown intended for use as a differential IN/differential OUT driver with gain set with external resistors

Uncommitted Quad Amplifier for ADSL Driver/Receiver (MAX4363)

The MAX4363 is a quad amplifier with shutdown intended for use as a differential IN/differential OUT driver/receiver combination with gain set with external resistors.

Shutdown

The MAX4362/MAX4363 feature a low-power shutdown mode. When the SHDN pin is pulled high, the supply current drops to 70µA, and the amplifier's outputs are placed in a high-impedance disable mode. Connect SHDN to GND for normal operation.

Applications Information

Power Supply and Decoupling

The MAX4361/MAX4362/MAX4363 should be powered from a well-regulated, low-noise, 4.5V to 5.5V supply in order to optimize the ADSL upstream drive capability to +12.5dBm and maintain the best SFDR.

High-quality capacitors with low equivalent series resistance (ESR) such as multilayer ceramic capacitors (MLCCs) should be used to minimize supply voltage ripple and power dissipation. A larger capacitor located in proximity to the MAX4361/MAX4362/MAX4363 improves decoupling for lower frequency signals.

In addition, 0.1µF MLCC decoupling capacitors should be located as close as possible to each of the power-supply pins, no more than 1/8 inch away. An additional large (4.7µF to 10µF) tantalum capacitor should be placed on the board near the supply terminals to supply current for fast, large-signal changes at the MAX4361/MAX4362/MAX4363 outputs.

MAX4361/MAX4362

The MAX4361/MAX4362 require a single 0.1µF bypass from V+ to ground located as close as possible to the IC leads.

MAX4363

The MAX4363 features separate supply and ground pins for the receiver and driver amplifiers. Bypass the V+ (RX) supply to the GND (RX) pin with a 0.1µF capacitor. Bypass the V+ (TX) supply to the GND (TX) pin with a separate 0.1µF capacitor. Both capacitors should be placed as close as possible to their respective IC leads.

USB Applications

The 5V supplied at the universal serial bus (USB) port may be poorly regulated or unable to supply the peak currents required by an ADSL modem. Improving the quality of the supply will optimize the performance of the MAX4361/MAX4362/MAX4363 in a USB-supplied CPE ADSL modem. This can be accomplished through the use of a step-up DC-to-DC converter or switching power supply followed by a low-dropout (LDO) regulator. Careful attention must be paid to decoupling the power supply at the output of the DC-to-DC converter, the output of the LDO regulator and the supply pins of the MAX4361/MAX4362/MAX4363.

Driving a Capacitive Load

The MAX4361/MAX4362/MAX4363 are capable of driving capacitive loads up to 2nF. Most hybrid circuits are well under this limit. For additional capacitive-drive capability use isolation resistors between the output and the load to reduce ringing on the output signal. In a typical hybrid the back-matching resistors provide sufficient isolation for most any capacitive-loading condition (see Figure 1).

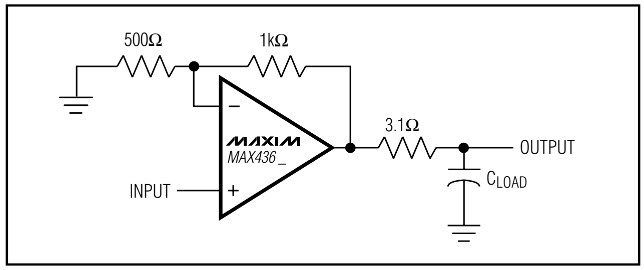


Figure 1. Driving Capacitive Load

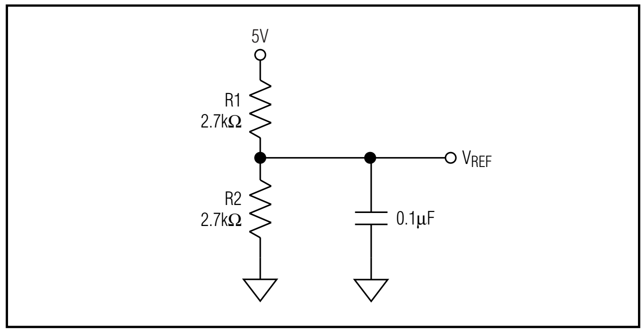


Figure 2. Voltage-Divider Reference

Method for Generating a Midsupply Voltage

To operate an amplifier on a single-voltage supply, a voltage midway between the supply and ground must be generated to properly bias the inputs and the outputs.

A voltage divider can be created with two equal-value resistors (Figure 2). There is a trade-off between the power consumed by the divider and the voltage drop across these resistors due to the positive input bias currents. Selecting 2.7kΩ for R1 and R2 will create a voltage divider that draws less than 1mA from a 5V supply. Use a decoupling capacitor (0.1µF) at the node where V_{REF} is generated.

Power Dissipation

It is important to consider the total power dissipation of the MAX4361/MAX4362/MAX4363 in order to properly size the heat sink area of an application. With some simplifying assumptions we can estimate the total power dissipated in the driver (see *Typical Operating*

ADSL Drivers/Receivers for Customer Premise Equipment

Circuit). If the output current is large compared to the quiescent current, computing the dissipation in the output devices and adding it to the quiescent power dissipation will give a close approximation of the total power dissipation in the package.

For a 12.5dBm average line power on a 100Ω line, the RMS current is 13.4mA. With a one-to-four transformer the driver therefore supplies 53.6mA RMS. It can be shown for a DMT signal the ratio of RMS current to the average rectified current is 0.8. The total power consumption is approximately

$$P_{CONS} = 0.8 \times 53.6 \times 5V = 214mW$$

of which 18mW is delivered as line power and 18mW is dissipated in the back-matching resistors. Hence the average power consumption of the IC is approximately 178mW + quiescent power (110mW), or 288mW. For the MAX4361 in an 8-pin µMAX package, this corresponds to a temperature rise of 64°C. With an ambient temperature of +85°C this corresponds to a junction temperature of +148°C, just below the absolute maximum of +150°C.

Please note the part is capable of over 200mA RMS, which could cause thermal shutdown in applications with elevated ambient temperatures and/or signals with low crest factors. See Figure 3 for a guide to power derating for each of the MAX4361/MAX4362/MAX4363 packages.

Transformer Selection

Full-rate, customer premise ADSL requires the transmission of a +12.5dBm (18mW) DMT signal. The DMT signal has a typical crest factor of 5.3, requiring the line driver to provide peak line power of 27.5dBm (560mW). The 27.5dBm peak line power translates into a 28.4V peak-to-peak differential voltage on the 100Ω telephone line. The maximum low-distortion output swing available from the MAX4361/MAX4362/MAX4363 line driver on a 5V supply is 3.8V and, taking into account the power lost due to the back-matching resistance, a step-up transformer with turns ratio of 3.8 or greater is needed. In the *Typical Operating Circuit*, the MAX4363 is coupled to the phone line through a step-up transformer with a 1:4 turns ratio. R1 and R2 are back-matching resistors, each 3.1Ω (100Ω / (2 × 4^2)), where 100Ω is the approximate phone-line impedance. The total differential load for the MAX4361/MAX4362/MAX4363, including the termination resistors, is therefore 12.5Ω. Even under these conditions the MAX4361/MAX4362/MAX4363 provide low distortion signals to within 0.6V of the power rails.

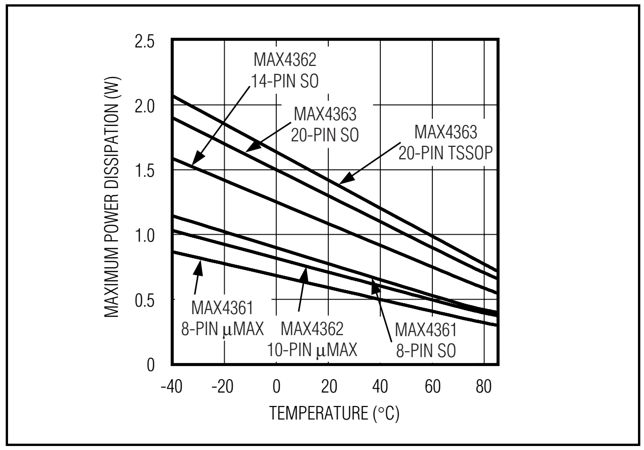


Figure 3. Maximum Power Dissipation vs. Temperature

Receive Channel Considerations

A transformer used at the output of the differential line driver to step up the differential output voltage to the line has the inverse effect on signals received from the line. A voltage reduction or attenuation equal to the inverse of the turns ratio is realized in the receive channel of a typical bridge hybrid. The turns ratio of the transformer may also be dictated by the ability of the receive circuitry to resolve low-level signals in the noisy, twisted-pair telephone plant. Higher turns-ratio transformers effectively reduce the received signal-to-noise ratio due to the reduction in the received signal strength.

The MAX4363 includes an amplifier with typical voltage noise of only 8.5nV/$\sqrt{Hz}$ and a low-supply current of 2mA/amplifier to be used as the receive channel.

Layout Considerations

Good layout techniques optimize performance by decreasing the amount of stray capacitance at the amplifier's inputs and outputs. Excess capacitance will produce peaking in the amplifier's frequency response. To decrease stray capacitance, minimize trace lengths by placing external components as close to the amplifier as possible.

Chip Information

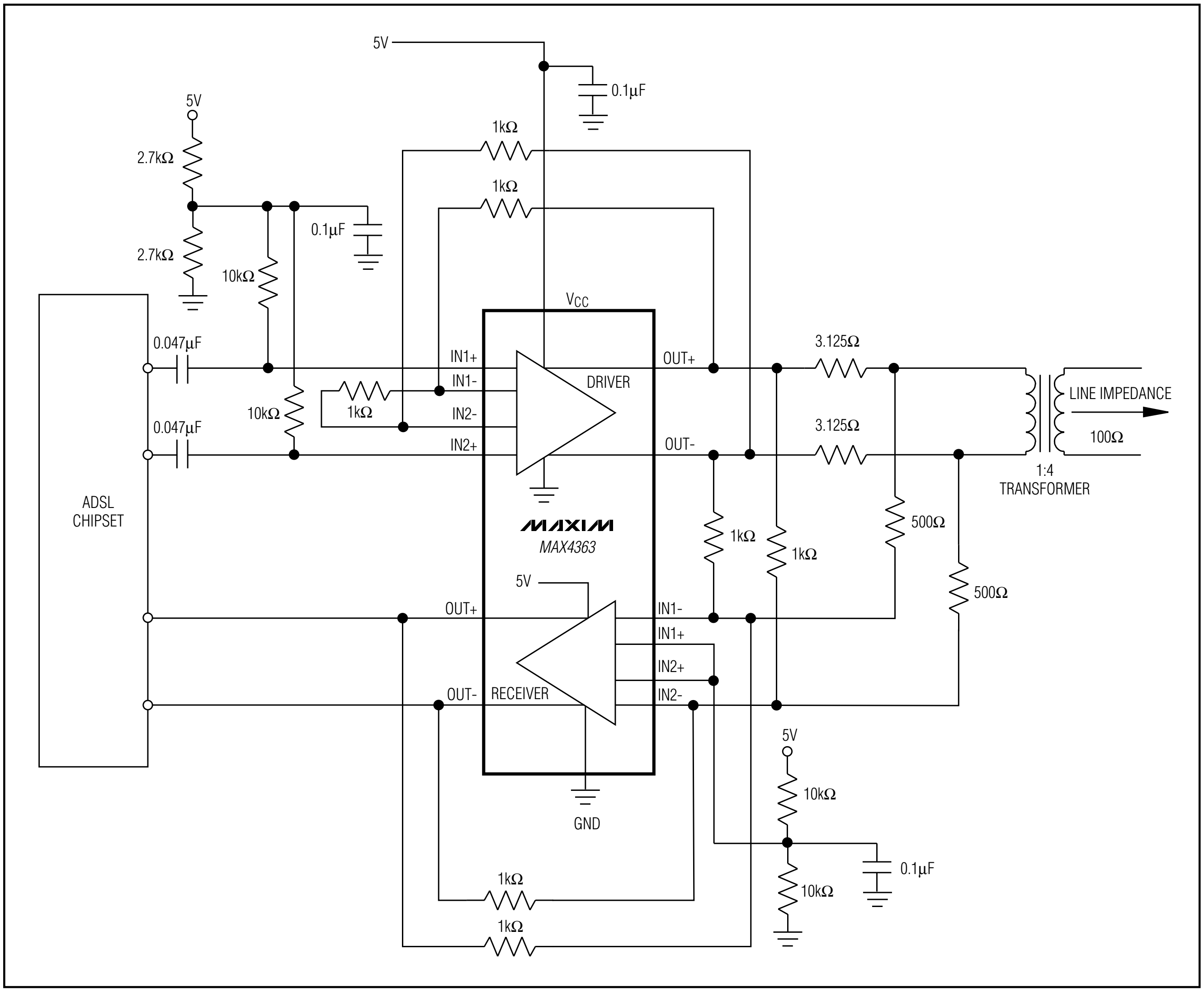
MAX4361 TRANSISTOR COUNT: 1400

MAX4362 TRANSISTOR COUNT: 1400

MAX4363 TRANSISTOR COUNT: 1750

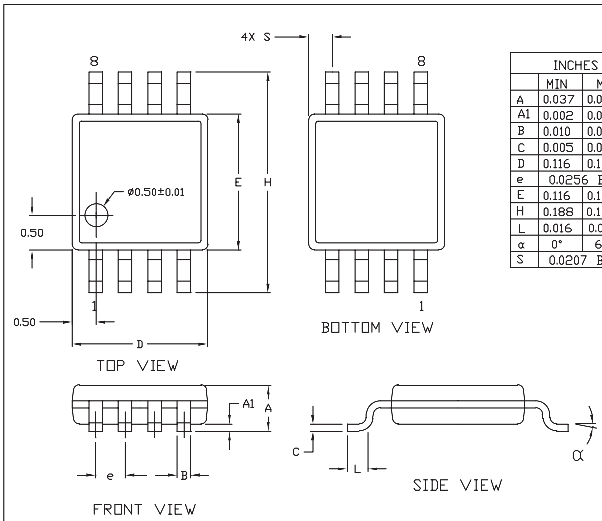
PROCESS: Bipolar

Typical Operating Circuit



ADSL Drivers/Receivers for Customer Premise Equipment

Package Information

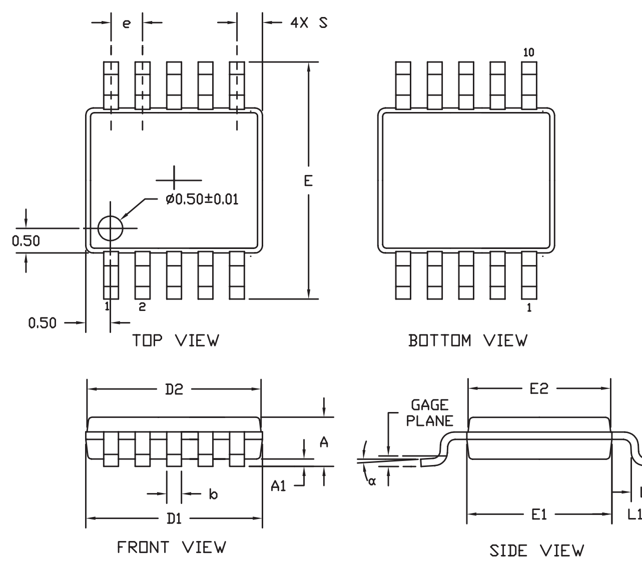


8LUMAXD.EPS

	JEDEC							
	INCHES		MILLIMETERS		INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, 8L uMAX
APPROVAL | DOCUMENT CONTROL NO. 21-0036 | REV I | 1/1



10LUMAX.EPS

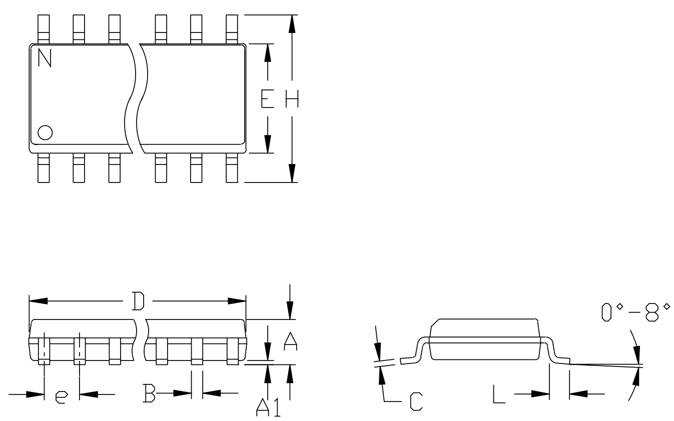
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10
A1	0.002	0.006	0.05	0.15
D1	0.116	0.120	2.95	3.05
D2	0.114	0.118	2.89	3.00
E1	0.116	0.120	2.95	3.05
E2	0.114	0.118	2.89	3.00
E	0.187	0.199	4.75	5.05
L	0.0157	0.0275	0.40	0.70
L1	0.037 REF		0.940 REF	
b	0.007	0.0106	0.177	0.270
e	0.0197 BSC		.500 BSC	
c	0.0035	0.0078	0.090	0.200
S	0.0196 REF		.498 REF	
α	0°	6°	0°	6°

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO187.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, 10L uMAX
APPROVAL | DOCUMENT CONTROL NO. 21-0061 | REV H | 1/1

Package Information (continued)

SOICN.EPS



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM
120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION

TITLE: PACKAGE FAMILY OUTLINE: SOIC .150"

1/1

DOCUMENT CONTROL NUMBER: 21-0041 REV: A